accompanied by explanations that have been prepared by trained observers who have been all over the ground, examining the forms of the surface as the expressions of internal structures. From the sheets in eastern Tennessee we may learn of the two peneplains that there give local illustration of wide-spread Appalachian forms. On the Livingston sheet, Montana, there is a fine illustration of one of the many extinct lake basins now drained through a steep-walled gorge, in a way so characteristic of the northern Rocky Mountains. With the Placerville sheet, in the California Sierra, the text tells of the reduction of the mountain belt to gentle slopes before the eruption of the great Neocene lava flows by which many of the older valleys were broadly filled; and of the deep canyons cut by the displaced rivers since the mountain belt has been upheaved with a westward slant. The plan of liberal distribution of these folios ensures that they will reach a wide variety of readers. They will be welcomed by many workers: students, teachers and investigators; geographers, geologists and economists.

GEIKIE'S GREAT ICE AGE.

THE third edition of this important work has been lately issued (New York, Appleton, 1895). Although distinctly a geological treatise, not written from the geographical point of view, it contains numerous pages of physiographic interest, for many glacial deposits are so young as still to preserve essentially their constructional form; hence the account of moraines, drumlins, rock-basins, and so on, are of immediate geographical value. The general subject of glacial erosion is hardly treated with the fulness that the many discussions it has given rise to would warrant; and the explanation of rock-basins does scanty justice to the opinions of many Swiss geologists who look on ice action as a secondary process compared to a gentle warping of pre-existent valleys. The extract from Wallace's paper, defending the glacial excavation of rock-basins, would imply that that author was not acquainted with the numerous lakes of dislocation in our western territory. For American readers the two chapters and the several maps by Chamberlin will prove attractive.

W. M. DAVIS.

HARVARD UNIVERSITY.

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*LABORATORY TEACHING OF LARGE CLASSES—ZOÖLOGY.**

IF the large and increasing attendance at our summer schools, and the publication of many books and the reports made by those dealing in scientific apparatus, can be taken as an index, the amount of zoölogical teaching is very rapidly increasing, and the conduction of large classes is a problem of considerable importance.

A class of college students numbering twenty or twenty-five, and conducted by one officer, is a large class and, even with a favorably equipped laboratory, is quite as large as a single teacher should attempt to carry. Of course, if a certain number of assistants can be engaged, a larger number of students can be directed, though this is virtually the establishment of so many subclasses.

One of the first conditions for successful zoölogical instruction is that of immediate environment. To crowd a score or more of katabolic youth into a small, miserably-lighted room, and compel them to breathe the fumes of stale alcohol for two or three hours, is to invite failure. Each student should have a table to himself where there is good light, and where he feels a certain amount of proprietorship. It should be so located that he is not tempted to carry on a clandestine parasitism, or even a symbiotic

* A paper read before the American Society of Naturalists at the Baltimore meeting, December 28, 1894.

existence with his neighbors. He should be provided with instruments, drawing and dissecting, that are his own, and these ought not to be handed down from class to class, broken and rusty and inheriting mutilations from a long line of ancestors. Each table should be provided with a drawer or locker in which towel, dissecting tray, books, notes, etc., can be safely kept, and any disposition towards untidiness should be censured.

I do not think that the best dissecting material obtainable is any too good for the college student. An advanced worker, or one of a small class, may perhaps profitably examine poorly prepared material, but nothing can more effectually dampen the enthusiasm of an instructor than to see a student *pour* from carapace to the dissecting dish the only too appropriately named 'soft-parts' of a crab or lobster. There is everywhere an abundance of good laboratory material, if the teacher will only exercise a little activity and foresight. With the numerous preserving fluids, and with alcohol free of duty, the student should have perfectly preserved material, unless living forms are available.

The compromise that is often made between the lecture and laboratory, by the mere exhibition of specimens or the passing of specimens from hand to hand during the lecture, is slipshod and dangerous. Such a display may come off once or twice a month, and if carefully conducted is of considerable value, but if occurring frequently there is bound to be a most unfortunate sameness in the style of presentation. The average student who has carefully dissected the cranium of the cat or sheep will take away with him a better understanding of the mammalian skull than he who has viewed acres of diagrams or handled, for a moment, the skulls of all the typical vertebrates.

In certain laboratories it is considered good form to prohibit, or at least to discourage, the free consultation of books of reference by the laboratory student. Pictures and diagrams, illustrating the animals under discussion, are supposed to poison the adolescent mind and should only be kept in the inner recesses of the professor's study, where he may occasionally retreat for a few moments of silent communication, after having been floored by a poser from one of his students. In my opinion, the student should be given every possible aid; there should be books galore; charts and diagrams should be conspicuous upon the wall; and fine dissections, made possibly by advanced students, anatomical preparations and models should be freely displayed upon the reference table. Prof. Howes, in his admirably equipped laboratory in London, has placed upon a ledge, running nearly around the room, a series of most beautiful dissections. In America these are too often hidden away in cases, and I fail to understand why the best of such material is placed in our museums, ostensibly for the education of the public, but actually to the sacrifice of the interests of the student.

Speakers at earlier meetings of this Society have, I think, not over-estimated the educational value of drawing, but we should be very careful that the permission to diagrammatize is not interpreted as permission for free-hand carelessness. The drawings should be carefully prepared; outline, composite pictures of the material studied.

It is unfortunate that we must introduce the microscope into our large class of 'zoology students.' The question of first expense, for every student must have an instrument, is a serious one, and then there is the time lost in giving a course in optics. Here, however, a little forethought will prevent much waste of the precious time actually appropriated to zoölogy. It is well to have one or two extra instruments in reserve, to use in case of accident, and there should be an abundance of the material

studied. I feel that one should be cautious in appropriating large time to the process of killing, staining, and other matters of pure technique, and especial care should be taken lest the disease of 'microtome-mania' become epidemic. The microtome is an instrument for the advanced worker and the investigator, but it is no uncommon thing to see a student, yielding to the blandishments of the instrument, cutting sections by the yard, when a few questions will reveal shameful ignorance of the gross anatomy of the animal imbedded.

One is inclined to think that the enthusiasm of the student is the proper index of the work accomplished. But it is not, at least not always. The course in zoölogy should be a course in zoölogy, and the student, certainly of the elementary class, should not be allowed to take alluring short cuts to histology, embryology and advanced morphology. There is a vast amount of microscopical work that can and ought to be done in our large classes. At Brown University the work of an entire term is upon the cat. The material is easy to procure; the organs are large, and I think the time of fifty students well spent. A critical study of other vertebrates should use up the two remaining terms of the year. The turtle and the snake very fairly represent the reptilian phylum; the latter, aside from popular prejudice, is a most satisfactory animal for the laboratory. I think it is a mistake not to more generally provide Elasmobranch material for the college student. When skate and 'dog-fish' can be so readily procured and so easily preserved, every zoölogical laboratory should have an abundance.

And now let me mention a condition, and the one upon which success with large classes most directly depends, viz., order and system. Though the members of our class are not all free and equal, as Americans they must be treated as such. The work of a certain day must be planned for the class as a whole, and not for individuals of the class. All students should have, at the beginning of the session, the same equipment, the same material, and matters of neatness should be enjoined upon all alike. The water in the dissecting trays must be frequently renewed, organic refuse must be disposed of, the tables must be kept dry, the instruments should not be allowed to soak in the bottom of the pan, or the pencil used as a probe. The table should not be smeared with blood, fat and alcohol. There should be a place for everything, and 'systematic zoölogy,' in the sense of order, should everywhere prevail. It is much easier for the student to become indifferent to the orderly side of zoölogy than it is for him to acquire respect for the cleanly.

A definite syllabus, placed upon the board, or laboratory outlines, one on each table, must be used. The latter can be prepared by the teacher and struck off with a cyclostyle or hectograph, and they are of immense help. The student knows what to do and when and how to do it. Extra paragraphs may be added for those who work more rapidly; though quality and not quantity should be the end.

The teacher, with his eye upon the whole class, must go from table to table, quizzing here and helping there. He must be ready to dissect mutilated specimens and reproduce lost parts instanter; and thankful is he, if not too frequently he is constrained to follow that motto placed by Professor Agassiz so conspicuously at Penikese: "Do not be afraid to say, I do not know."

I must beg your forbearance while I say a few words in regard to the large zoölogy classes in our secondary schools. It is my opinion that laboratory classes, conducted along the lines which we have just mentioned, are not at the present time to be too strongly urged for the common schools. There are very few teachers who have had

proper training for this kind of work, though the number is happily on the rapid increase. The 'hard parts' of the lower animals, starfish, urchins, molluscs, crustacea, insects, etc., offer ample opportunity for elementary zoölogical work, but it seems to be hardly advisable to largely recommend the dissecting of mammals by the average class, though I think the isolated parts, eye, bones of the ear, the tongue, heart, brain, etc., can be properly and very profitably used. Elaborate outfits of dissecting instruments are not here necessary, though one or two microscopes are desirable. In the secondary school there is a splendid opportunity for the cultivation of the observational powers, by comparing the external characters of animals; by observing habits; how the bird breathes; how it involuntarily grasps the branch; the adaptation of structure to use in the feet of waders, scratchers and singing birds; the structure of the scale and feathers, and claws; the pneumaticity of the bones; the preening of the feathers; the dull coloring of the female; the shapes and colors of eggs and any peculiar nesting habits. It is all wrong for a child to think that zoölogy can only be learned over a dissecting dish. The fundamental principles of biology, the theory of adaptation, protective coloring, protective and aggressive mimicry, distribution, degeneration, parasitism and development can all be illustrated to and understood by the school-child who has never held a scalpel.

The school-room already has its plants; it should also have its local collection. The children make most enthusiastic and active collectors. It is not necessary that the teacher should be qualified to give off-hand the sesquipedalian scientific name of each and every insect that is brought to the school. A far better goal is reached when the student is taught to recognize homologies, to place grasshoppers, katydids and crickets together, to have a separate apartment for butterflies and moths, and another for beetles, etc. Perhaps certain students may be interested in the molluscan fauna of the neighborhood and others may choose to collect cocoons. (I recently read in one of the ubiquitous anti-vivisection papers that the lung of the pond-snail is provided with most beautiful rows of minute horny teeth. Early observations would not only correct such aberrations, but would secure a familiarity with natural phenomena which would give that philosophical training that is often so lamentably lacking in our educated classes.) The child is delighted with the movements of aquatic animals. Aquaria should be in every school. There are hundreds of animals to be collected in any pond or stream, and how easy is it to here find themes for written exercises and models for drawing!

The zoölogy of the secondary school should not be merely an isolated subject of study. It is not attractive to some, and knowledge cannot be forced upon unwilling minds; but it can be unconsciously absorbed in solution. Zoölogy then should enter into the reading, the writing, the spelling, the arithmetic; geography is stupid without it, and the history of human progress is but distribution with the consequent 'struggle for existence' and the 'survival of the fittest.'"

HERMON C. BUMPUS.

BROWN UNIVERSITY.

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*NOTES ON THE BIOLOGY OF THE LOBSTER.**

Reproduction.—After hatching a brood in May, the female usually molts and afterwards extrudes a new batch of eggs. In

*This paper was read before the Society of Morphologists, Baltimore, December 28th.

The following observations are from part of a prolonged investigation of the habits and development of the lobster, undertaken for the U. S. Fish Commission. The detailed work, now ready to go to press, will be published in the Fish Commission's Bulletin. It will contain a full presentation and discussion of the habits and general life-history of the adult lob-